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GENERAL AVIATION DYNAMICS

AN EXTENSION OF THE COST IMPACT STUDY TO INCLUDE DYNAMIC INTERACTIONS IN THE FORECASTING OF GENERAL AVIATION ACTIVITY

VOLUME III. PLANNING GUIDE

APRIL 1977

FINAL REPORT

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Office of Aviation Policy
Aviation Forecast Branch
Washington, D.C. 20591

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16. Abstract

This report, in four volumes, presents the General Aviation Dynamics (GAD) model which was developed for the Federal Aviation Administration by Battelle's Columbus Laboratories. The GAD model is a dynamic simulation model of the general aviation (GA) system and can be used to forecast GA activity, evaluate alternative policy actions, or perform sensitivity analyses. It has three major sectors, depicting the most important state variables in the model; pilot supply, aircraft utilization, and aircraft demand.

Essentially, the GAD model consists of a set of nonlinear, simultaneous, first order difference equations which explicitly describe the decision policies followed by users of general aviation. The model is designed to be implemented through an interactive computer dialogue feature that quides the analyst through a series of procedures and analytical options.

The volumes included in this report are:

Volume I - Executive Summary
Volume II - Research Methodology
Volume III - Planning Guide
Volume IV - Data Base

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FINAL REPORT

on

GENERAL AVIATION DYNAMICS
AN EXTENSION OF THE COST IMPACT STUDY TO INCLUDE DYNAMIC INTERACTIONS IN THE FORECASTING OF GENERAL AVIATION ACTIVITY

VOLUME III. PLANNING GUIDE

to

FEDERAL AVIATION ADMINISTRATION
OFFICE OF AVIATION POLICY

from

BATTELLE
Columbus Laboratories

by

M. A. Duffy, G. L. Eiden, C. W. Hamilton and V. J. Drago

December 31, 1976

CHAPTER 1. INTRODUCTION

The General Aviation Dynamics model is implemented in NUCLEUS*, a computer software system developed at Battelle. It can be accessed almost any time and from anywhere in the U. S., provided a telephone, an on-line terminal, and an authorized user name and password are available. This Volume will detail the procedures of logging into and out of the Battelle Computer System, initiating interaction with NUCLEUS, and using the GAD model for forecasting and sensitivity analyses. Required inputs, possible outputs and an illustrative example are presented.

The NUCLEUS Software System

NUCLEUS, a dynamic simulation and modeling system, has been evolving at Battelle over the last decade and has proved a valuable research tool in numerous multidisciplinary research projects. It began as an interpreter for dynamic

*NUCLEUS = NUmerical CLassification and EvalUation System

simulation modeling (using difference equation techniques) but it has grown into a large batch and on-line system with extensive data management capabilities to handle large and complex demographic, economic, land-use and electric power demand forecasting models.

In more detail, NUCLEUS has the following features:

(1) It is a high-level programming language (with capabilities like FORTRAN but with a structured syntax). The structured nature of NUCLEUS versus FORTRAN is manifest in the fact that NUCLEUS has no statement labels. Thus, you will find no GO TO statements in any NUCLEUS program. In addition, each NUCLEUS command is a structured complex of stored information and instructions.

(2) It is an interpreter for dynamic simulation modeling (using the same difference equation techniques as the DYNAMO system developed at M.I.T.). Each NUCLEUS command is interpreted and executed as soon as it is entered, except in some cases where a sequence of commands are interpreted and compiled into a model or procedure first, before being called into execution.

(3) It has a data-base management component for storage, retrieval, and analysis of primarily numerical data files which may be interfaced with dynamic models.

(4) It has a generalized report generator for tabular output (and line printer graphical output).

(5) It is available for local batch, remote batch, and on-line use. Batch and on-line programs are completely interchangeable.

(6) It allows interface with FORTRAN, i.e., a NUCLEUS program may call programs written in the FORTRAN language (not vice-versa).

(7) It allows the construction of conversational (in plain English) on-line systems for use by people who are not computer oriented.

(8) It is partially machine-dependent. It is operational on a Control Data environment, but some of its components may be loaded and run at non-CDC computers without any conversion, while other components may need some conversion. This is possible because the NUCLEUS interpreter is a library of programs written mostly in FORTRAN.

(9) It has generalized error trace back.

Login/Logout Procedures for the Battelle Computer System via TYMNET

(1) Dial TYMNET number from the list on Table 3-1
Wait for data tone from TYMNET connection.

(2) Place telephone headset in acoustic coupler, or initialize other type of modem.

(3) The message

PLEASE ENTER TERMINAL IDENTIFIER

is printed or displayed on the terminal. On some terminals this line will print as "garbage". If this occurs simply continue with Step (4).

(4) Type the appropriate identifier for your terminal from the list on Table 3-2.

(5) TYMNET responds:

PLEASE LOGIN:

(6) Login by typing the sequence

(CTRL H) BCL;BASIS70 (CR)

where

(CTRL H) denotes simultaneous keying of the control and H keys, and (CR) denotes keying of the carriage return (or cursor return) key.

No blanks (spaces) are allowed in the above sequence. Wait a few seconds (about 10) for connection with the Battelle INTERCOM system. The TYMNET username/password combination (BCL;BASIS70) should be treated with discretion and made available only to users with valid Battelle username/password combinations.

(7) INTERCOM responds:

BATTELLE INTERCOM 4.5
DATE MM/DD/YY
TIME HH.MM.SS.

PLEASE LOGIN

(8) Enter the following sequence:

LOGIN,username,password,SUP(CR)

where username and password are valid code words issued by the Battelle Computer Center. No blanks (spaces) are allowed in the above sequence.

(9) INTERCOM responds:

COMMAND-

(10) Carry out dialogue with INTERCOM

(11) To exit from INTERCOM normally, enter

LOGOUT

after the INTERCOM prompt COMMAND-

(12) To exit from INTERCOM abnormally (i.e., abort), enter the sequence

```
% A
```

after a system pause. Or, if in the middle of a lengthy response, enter the sequence

```
(CTRL Z) % A
```

where

(CTRL Z) denotes the simultaneous keying of the control and Z keys. This keying causes the system response to halt.

After an abnormal termination, the system responds

```
USER ABORT
COMMAND-
```

At this point, you may log out normally.

(13) After LOGOUT, the system gives you an itemized summary of your interaction with the Battelle Computer. This summary looks like the following:

```
CP    X.XXX SEC.
IO    Y.YYY SEC.
CM    Z.ZZZ SEC.
SS    S.SSS SEC.
CH      CCC CHARS.
CONNECT TIME H HRS. M MIN. MM/DD/YY
LOGGED OUT AT HH.MM.SS.
```

where

CP is the central processor time of your run
IO is a measure of your use of peripheral equipment
CM is a measure of your use of central memory
SS is the combined amount of computer time for which you are charged
CH is the number of characters transmitted
CONNECT TIME is the time between login and logout.

The cost for TYMNET services is approximately 17¢ per connect minute which is in addition to the normal INTERCOM processing cost incurred. These charges are subject to change.

NOTES:

- To backspace, type CTRL and H simultaneously
- To skip a line of entry, type CTRL and X simultaneously
- To suspend printing, type CTRL and Z simultaneously
- To abort, enter %, then A.
- All user entries must be terminated by (CR).

TABLE 3-1. LIST OF TYMNET TELEPHONE NUMBERS, AS OF JULY 15, 1975

9-14-76

NODE	CITY	STATE	NAME	T	HD	PHONE	
1076	PHOENIX	ARIZONA	PHO1	C		602/249-9261	
1117	CUPERTINO	CALIFORNIA	WCOSR1	C	**	RESTRICTED	
1127	CUPERTINO	CALIFORNIA	CRPSR2		**	RESTRICTED	
1001	CUPERTINO	CALIFORNIA	CRP1	E	**	RESTRICTED	
1155	CUPERTINO	CALIFORNIA	CRPSR1		**	RESTRICTED	
1070	CUPERTINO	CALIFORNIA	LAB1	E	**	RESTRICTED	
1006	EL SEGUNDO	CALIFORNIA	ELS1	C	**	213/640-1570	
1144	LOS ANGELES	CALIFORNIA	LA1		**	213/687-8083	(1200 VADIC)
1037	LOS ANGELES	CALIFORNIA	LASR1	C	**	213/629-1561	
1144	LOS ANGELES	CALIFORNIA	LA1		**	213/629-3001	(1200 BELL)
1027	LOS ANGELES	CALIFORNIA	LA2	E	**	213/683-0451	
1060	MOUNTAIN VIEW	CALIFORNIA	AME1	E	**	415/965-8615	
1024	NEWPORT BEACH	CALIFORNIA	DC2	C	**	714/540-9560	
1010	OAKLAND	CALIFORNIA	OAK1	E	**	415/465-7000	
1007	OXNARD	CALIFORNIA	OX1	C	**	805/487-0482	
1017	PALO ALTO	CALIFORNIA	PA1	C	**	415/494-3900	
1072	PALO ALTO	CALIFORNIA	PCOSR1	E	**	415/326-7015	
1055	RIVERSIDE	CALIFORNIA	COL1	C	**	714/825-9372	
1052	SACRAMENTO	CALIFORNIA	SAC1	E		916/441-5450	
1025	SAN DIEGO	CALIFORNIA	SDSR	C		714/291-8700	
1126	SAN FRANCISCO	CALIFORNIA	SFSR1	C	**	415/421-9240	
1126	SAN FRANCISCO	CALIFORNIA	SFSR1	C	**	415/391-9325	
1136	SAN JOSE	CALIFORNIA	SJS1	C	**	408/984-5500	
1054	SAN JOSE	CALIFORNIA	CRP2		**	408/446-7003	(1200 BELL)
1000	SAN JOSE	CALIFORNIA	WCOSR2	C	**	RESTRICTED	
1054	SAN JOSE	CALIFORNIA	CRP2		**	408/446-6932	(1200 VADIC)
1000	SAN JOSE	CALIFORNIA	WCOSR2		**	408/257-0593	(CCITT)
1170	SUNNYVALE	CALIFORNIA	LOCSR2		**	RESTRICTED	
1020	SUNNYVALE	CALIFORNIA	LOC1	C	**	RESTRICTED	
1174	CALGARY	CANADA	EDM1	C		403/263-0487	(30 CPS)
1174	CALGARY	CANADA	EDM1	C		403/263-2006	(14.8 CPS)
1174	CALGARY	CANADA	EDM1	C		403/263-2072	(10 CPS)
1174	EDMONTON	CANADA	EDM1	C		403/452-7014	
1174	MONTREAL	CANADA	EDM1	C		514/878-0589	(1.48 CPS)
1174	MONTREAL	CANADA	EDM1	C		514/878-0588	(10 CPS)
1174	MONTREAL	CANADA	EDM1	C		514/878-0584	(30 CPS)
1174	TORONTO	CANADA	EDM1	C		416/863-6202	(30 CPS)
1174	TORONTO	CANADA	EDM1	C		416/863-6252	(10 CPS)
1174	TORONTO	CANADA	EDM1	C		416/863-6277	(14.8 CPS)
1174	VANCOUVER	CANADA	EDM1	C		604/688-4338	(10 CPS)
1174	VANCOUVER	CANADA	EDM1	C		604/688-4838	(14.8 CPS)
1174	VANCOUVER	CANADA	EDM1	C		604/688-9811	(30 CPS)
1065	DENVER	COLORADO	DEN1	E		303/458-7921	
1033	DARIEN	CONNECTICUT	DAR1	C		203/655-8931	
1041	HARTFORD	CONNECTICUT	HAR1	C		203/568-2610	
1011	WASHINGTON	DC	WASSR1	C	**	703/841-9560	
1011	WASHINGTON	DC	WASSR1		**	703/525-9164	(1200 VDC)
1011	WASHINGTON	DC	WASSR1		**	703/527-7106	(1200 BELL)
1022	WASHINGTON	DC	WASSR2	E	**	703/521-6520	
1124	MIAMI	FLORIDA	MIA1	C		305/374-7115	
1066	ST. PETERSBURG	FLORIDA	STP1	C		813/536-7823	
1066	TAMPA	FLORIDA	STP1	C		813/223-3787	
1064	ATLANTA	GEORGIA	ATL1	C		404/659-6670	
1133	HONOLULU	HAWAII	OAHU	C		808/521-7481	
1141	CHICAGO	ILLINOIS	CHI1		**	312/372-0391	(1200 VDC)
1116	CHICAGO	ILLINOIS	CHISP1	C	**	312/368-4607	
1141	CHICAGO	ILLINOIS	CHI1		**	312/368-0022	(1200 BELL)
1012	CHICAGO	ILLINOIS	CHI2	E	**	312/346-4961	
1004	FREEPORT	ILLINOIS	MIL1	C		815/232-8186	(10 CPS)
1004	FREEPORT	ILLINOIS	MIL1	C		815/232-8181	(30 CPS)
1103	DES MOINES	IOWA	DMS1	C		515/280-9600	
1167	WICHITA	KANSAS	WITSR1	C		316/265-7781	
1046	BATON ROUGE	LOUISIANA	BAT1	C		504/927-6400	
1050	NEW ORLEANS	LOUISIANA	NO1	C		504/586-1071	
1056	BALTIMORE	MARYLAND	BAL1	C	**	301/547-8100	

TABLE 3-1. LIST OF TYMNET TELEPHONE NUMBERS, AS OF JULY 15, 1975 (Continued)

NODE	CITY	STATE	NAME	T	HD	PHONE	
1115	BOSTON	MASSACHUSETTS	BOSCP1	C	**	617/964-3900	
1040	BOSTON	MASSACHUSETTS	BOS3	E	**	617/964-3925	
1115	BOSTON	MASSACHUSETTS	BOSCP1		**	617/965-5520	(1200 VDC)
1115	BOSTON	MASSACHUSETTS	BOSCP1		**	617/244-1240	(1200 BELL)
1074	CAMBRIDGE	MASSACHUSETTS	CBP1	E	**	617/491-5476	
1005	ANN ARBOR	MICHIGAN	MDCSR1	C	**	RESTRICTED	
1111	ANN ARBOR	MICHIGAN	MDC2	C	**	313/995-6260	
1122	DETROIT	MICHIGAN	DET3		**	313/963-3353	(1200 VDC)
1107	DETROIT	MICHIGAN	DET2	C	**	313/963-3388	
1122	DETROIT	MICHIGAN	DET3		**	313/963-4676	(1200 BELL)
1057	JACKSON	MICHIGAN	CP1	C		RESTRICTED	
1104	KALAMAZOO	MICHIGAN	KAL1	C		616/385-3150	
1013	SOUTHFIELD	MICHIGAN	DET1	C	**	313/355-2950	
1175	MINNEAPOLIS	MINNESOTA	MPLSR1	C		612/854-6659	
1114	KANSAS CITY	MISSOURI	KC1	C		816/421-7444	
1043	ST LOUIS	MISSOURI	SL1	C		314/421-5110	
1131	DURHAM	N.C.	DUR1	C		919/549-0441	
1035	ENGLEWOOD CLIFFS	NEW JERSEY	NJ1	C	**	201/894-8250	
1073	UNION	NEW JERSEY	UN1SR1	E	**	201/964-6300	
1053	WAYNE	NEW JERSEY	GPI1	E	**	201/785-4777	
1003	BUFFALO	NEW YORK	BUFSR1	E		716/856-1400	
1112	NEW YORK	NEW YORK	NYCSR2	C	**	212/750-9445	
1044	NEW YORK	NEW YORK	NY3		**	212/689-8850	(1200 BELL)
1036	NEW YORK	NEW YORK	NY1	E	**	212/344-7445	
1044	NEW YORK	NEW YORK	NY3		**	212/689-8910	(1200 VDC)
1112	NEW YORK	NEW YORK	NYCSR2	C	**	212/750-9433	
1034	NEW YORK	NEW YORK	NYCSR1	E	**	212/532-7615	
1034	NEW YORK	NEW YORK	NYCSR1	E	**	212/551-9322	
1016	ROCHESTER	NEW YORK	RDC1	C		716/546-1410	
1015	SYRACUSE	NEW YORK	SYR1	E		315/437-7111	
1172	AKRON	OHIO	CLV1	C		216/434-4523	(10 CPS)
1172	AKRON	OHIO	CLV1	C		216/434-4593	(30 CPS)
1071	CINCINNATI	OHIO	CIN1	C		513/621-7460	
1172	CLEVELAND	OHIO	CLV1	C		216/781-7050	
1026	COLUMBUS	OHIO	CLBSR1	C		614/421-7270	
1101	OKLAHOMA CITY	OKLAHOMA	OKL1	C		405/947-0561	
1167	TULSA	OKLAHOMA	WITSR1			918/492-5306	(30 CPS)
1051	PORTLAND	OREGON	POR1	C		503/224-0750	
1032	ALLENTOWN	PENNSYLVANIA	PHISR1	C		215/433-6131	
1032	PHILADELPHIA	PENNSYLVANIA	PHISR1	C		215/561-6120	
1063	PITTSBURGH	PENNSYLVANIA	PIT1	C		412/765-1320	
1173	VALLEYFORGE	PENNSYLVANIA	VFOSR1	E		215/666-9190	
1031	MEMPHIS	TENNESSEE	MEM1	C		901/396-4411	
1045	AUSTIN	TEXAS	AUS1	C		512/444-3280	
1030	DALLAS	TEXAS	DAL1	C		214/638-5800	
1171	EL PASO	TEXAS	EPSO	C		915/544-9590	
1134	HOUSTON	TEXAS	HOUSR1	C	**	713/785-4411	
1134	HOUSTON	TEXAS	HOUSR1	C	**	713/785-4420	
1137	HOUSTON	TEXAS	HOU2		**	713/780-7390	
1014	MIDLAND	TEXAS	MDL1	C		915/683-5645	
1102	SAN ANTONIO	TEXAS	SA1	E		512/734-7381	
1021	SALT LAKE CITY	UTAH	SLK1	C		801/582-6972	
1023	SEATTLE	WASHINGTON	SEA1	C		206/622-7930	
1004	MADISON	WISCONSIN	MIL1	C		608/221-4211	(30 CPS)
1004	MILWAUKEE	WISCONSIN	MIL1	C		414/257-3482	

NODE	CITY	COUNTRY	NAME	T	HD	PHONE	
1042	LONDON	ENGLAND	LON1	E	**	01-568-4455	
1061	PARIS	FRANCE	PAR1	C	**	602-55-00	
1067	PARIS	FRANCE	PAR3	E	**	260-36-35	
1075	BRUSSELS	BELGIUM	BRX1	E	**	640-0215	
1113	THE HAGUE	HOLLAND	HAG1	C		46-97-61	
1125	LAUSANNE	SWITZERLAND	PAR4	E	**	(21)25-66-34	(30 CPS)
1125	LAUSANNE	SWITZERLAND	PAR4	E	**	(21)25-43-57	(10 CPS)
1165	LONDON	ENGLAND	LON2	C	**	01-568-3711	

TABLE 3-2. USER TERMINAL IDENTIFICATION CODES

Identifying Character	Terminal	Speed In/Speed Out
A	All CRT	30/30
C	Beta, Guiton	30/30
E	All Thermal	30/30
G	MEM, GE Terminet	30/30
B	Mod 37, CRT	15/15 (odd parity)
F	Beta	15/30
J	ALL CRT	15/15 (even parity)
N	All Thermal	15/30
CR	2741	13.5/13.5
D	TTY, CRT	10/10

Type (CTRL H) after identifying character, but before username to denote a half duplex terminal.

Type (CTRL F) to denote full duplex terminal.

Login/Logout Procedures for the Battelle Computer System and the NUCLEUS System via Direct Dial-Up

(1) Dial (614)424-5850. Telephone will ring; a high-pitched tone follows.

(2) Place receiver in coupler. The green carrier light will come on. Terminal is connected to computer.

(3) Key CR (carriage return) to indicate the terminal's baud (300 or 110) to the Battelle CDC equipment.

(4) A message like the following is displayed or printed on the terminal:

```
BATTELLE INTERCOM 4.5
DATE MM/DD/YY
TIME HH.MM.SS.

PLEASE LOGIN
```

(5) Enter the following sequence:

```
LOGIN,username,password,SUP.(CR)
```

where username and password are valid code-words issued by the Battelle Computer Center. No blanks (spaces) are allowed in the above sequence.

NOTE: To correct mistakes in a given line of entry, backspace to the character in error by pressing the CTRL and H keys simultaneously as many times as necessary. Then retype the remainder of the line.

NOTE: To skip a line of entry altogether, press the CTRL and X keys simultaneously. Then continue entering correct information

NOTE: (CR) denotes carriage return (or cursor return).

(6) The Battelle INTERCOM system responds:

```
COMMAND-
```

To extend the time allowed for the on-line interaction, enter

```
ETL,20
```

This ensures enough time for the entire interactive dialogue, calculations, and desired output. The system will again respond:

COMMAND

(7) To begin the dynamic simulation model, enter NUCLEUS,AVIATION.

(8) To terminate abnormally at any time the interaction with NUCLEUS:

- If at a system pause, enter %, then A, then (CR).
- If in the middle of a lengthy NUCLEUS, response, enter CTRL and Z simultaneously, then %, then A, then (CR).

(9) INTERCOM responds:

USER ABORT
COMMAND-

(10) To exit from INTERCOM, enter

LOGOUT

any time you have the prompt COMMAND

(11) After an exit from NUCLEUS, you are back in INTERCOM with the prompt

COMMAND

you may enter the dynamic simulation model again or end your interaction with the system

(12) To exit from INTERCOM, enter

LOGOUT

(13) After LOGOUT, don't forget to hang up the phone.

Examples of login/logout procedures are displayed on Table 3-3.

TABLE 3-3. LOGIN/LOGOUT PROCEDURES - EXAMPLES

All user entries are underlined. It is assumed that you have already dialed in, either directly or via TYMNET.

(1) Login/logout for INTERCOM. Long format. User password in overwritten.

```
BATTELLE INTERCOM 4.5
DATE  11/09/76
TIME  09.06.16.

PLEASE LOGIN
LOGIN,AVIATION
**********  ENTER PASSWORD-
DATE AND TIME OF LAST NEWS
11/08/76 08.00
TYPE Y OR NN


11/09/76   LOGGED IN AT  09.06.32.
           WITH USER-ID ME
           EQUIP/PORT 01/057
COMMAND- LOGOUT
CP            .056  SEC.
IO            .208  SEC.
CM            .017  SEC.
SS           1.000  SEC.
CH             235  CHARS.
CONNECT TIME    0 HRS.    0 MIN.
 11/09/76  LOGGED OUT AT  09.06.46.
      <
```

(2) Login/logout for INTERCOM. Short format. User password is shown explicitly.

```
BATTELLE INTERCOM 4.5
DATE  11/09/76
TIME  09.03.00.

PLEASE LOGIN
LOGIN,AVIATION,DEMO,SUP,N
COMMAND- LOGOUT
CP            .043  SEC.
IO            .208  SEC.
CM            .016  SEC.
SS           1.000  SEC.
CH               0  CHARS.
CONNECT TIME    0 HRS.    0 MIN.
 11/09/76  LOGGED OUT AT 09.03.33.
      <
```

(3) Login/logout for INTERCOM and NUCLEUS

```
BATTELLE INTERCOM 4.5
DATE  11/09/76
TIME  09.07.12.

PLEASE LOGIN
LOGIN,AVIATION,DEMO,SUP,N.
COMMAND- LOGOUT
CP            .044  SEC.
IO            .208  SEC.
CM            .016  SEC.
SS           1.000  SEC.
CH               0  CHARS.
CONNECT TIME    0 HRS.    0 MIN.
 11/09/76  LOGGED OUT AT 09.07.30.
      <
```

(4) Login/logout for INTERCOM. Long format, with error in *username/password* combination.

```
BATTELLE INTERCOM 4.5
DATE  11/09/76
TIME  09.04.44.

PLEASE LOGIN
AVIATION
FORMAT ERROR
READY..LOGIN,AVIATION
**********  ENTER PASSWORD-
INVALID USER NAME OR PASSWORD
ENTER USER NAME-AVIATION
**********  ENTER PASSWORD-
DATE AND TIME OF LAST NEWS
11/08/76 08.00
TYPE Y OR NN


11/09/76   LOGGED IN AT  09.05.39.
           WITH USER-ID ME
           EQUIP/PORT 01/057
COMMAND- LOGOUT
CP            .098  SEC.
IO            .285  SEC.
CM            .026  SEC.
SS           1.000  SEC.
CH             365  CHARS.
CONNECT TIME    0 HRS.    0 MIN.
 11/09/76  LOGGED OUT AT 09.05.50.
      <
```

CHAPTER 2. INPUT/OUTPUT CONSIDERATIONS

Data required for the baseline general aviation forecast are entirely self-contained within the model. The assumed values for pertinent variables may be displayed by responding appropriately to the interactive dialogue. These values may be changed at the terminal (or in batch) by the user. The user may then display the new entries to ensure that they were entered correctly. Results of the forecast are obtained in tabular and/or plot form by responding to the interactive dialogue.

Baseline Data

In the absence of new data input by the user, the following national economic forecasts are used as exogenous inputs:

YEAR	GNP	DPI
1975	1.0176	1.0443
1976	1.0810	1.0980
1977	1.1360	1.1480
1978	1.1600	1.1790
1979	1.1920	1.2000
1980	1.2250	1.2360
1981	1.2530	1.2510
1982	1.2820	1.2690
1983	1.3080	1.2850
1984	1.3600	1.3330

Both GNP and DPI are measured in constant (1972) dollars and indexed to the 1972 value (1972=1.000). These estimates are representative of the baseline forecast from the Wharton national economy model.

Fixed and variable costs of aircraft operation are also required through 1984. The following inflation factors (in constant 1972 dollars) are applied to the 1975 values for these costs:

Year	Variable Cost Inflation Factor	Fixed Cost Inflation Factor
1975		
1976	.999	.984
1977	1.014	.984
1978	1.028	.984
1979	1.040	.981
1980	1.064	.988
1981	1.088	.998
1982	1.110	1.007
1983	1.127	1.013
1984	1.144	1.019

A measure of commercial air traffic is needed through 1984. The following index for Revenue Aircraft Departures (also called Mobility Index) is based upon the most recent FAA projections. These values are indexed to the 1972 value (1972 = 1.000):

Year	Revenue Aircraft Departures (1972=1.0)
1975	.933
1976	.943
1977	.973
1978	.993
1979	1.023
1980	1.053
1981	1.092
1982	1.112
1983	1.142
1984	1.172

As was discussed in Volume II, the estimated U. S. population by age group is required in forecasting active pilot population. However, since this is essentially a deterministic function, there is no provision for its modification.

Optional Input

In addition to these five rather gross parameters in the baseline data, it is possible to change the fixed or variable cost for any aircraft type during any year(s) of the simulation. Moreover, the following individual cost centers can be changed similarly: fuel and oil (through fuel tax), annualized investment, and imposition of landing fees at towered airports.

Available Output

Several different types of tabular output and graphic output are available. The user may display the options at the terminal after the results of the forecast are computed. Chapter 3 contains an example forecast which lists the available options.

CHAPTER 3. AN EXAMPLE OF THE GENERAL AVIATION DYNAMICS MODEL IN THE INTERACTIVE MODE

Sensitivity Analysis

In general, there are two ways to use model results or simulations - individually as projections and in pairs as sensitivity measures. Use of the model simply to make projections is fraught with dangers. Many potential users will not understand how the projections were derived and will expect unreasonable accuracy. The model is better used by employing extensive sensitivity analysis to evaluate a range of policies under a range of exogenous conditions. This process will identify the principal areas of model uncertainty and those portions of the model that deserve the greatest additional research.

The logical structure of the GAD model has been constructed such that relative comparisons can be made between the model forecasts from any two simulations. In particular, during a sensitivity analysis, absolute forecasts for each simulation are available, as well as percent deviations between the two cases. These deviations can be displayed over time either graphically or in tabular format.

A sensitivity analysis can be performed between any two simulations which are compatible with the model's capabilities. All GAD model output data from the first simulation are stored on a separate temporary file. This base case need not be the "baseline" forecast representative of expected future conditions, but can be the result of any consistent set of conditions chosen by the analyst. Intermediate absolute forecast results from this base case can be obtained by the analyst, if desired. After obtaining all required intermediate output, the second simulation is specified and run. Absolute results of the second simulation are also available to the analyst. Sensitivity results are derived within the program logic by subtracting the results of the first simulation from the second simulation, dividing by the first simulation, and multiplying by 100 to convert differences to percent deviations from the base case; mathematically,

$$\% \text{ Deviation} = \frac{AA(I,J)_2 - AA(I,J)_1}{AA(I,J)_1} \times 100$$

where,

$AA(I,J)_1$ = the number of active aircraft of type J within category I from the first (base) simulation

$AA(I,J)_2$ = the number of active aircraft of type J within category I from the second simulation

Values for these parameters are, of course, obtained at the same instant in time during their respective simulations.

Should conditions within the second simulation not change immediately from the base case, percent deviations, until the change becomes effective, will be zero. Furthermore, by continually computing these deviations over time, the non-linearity in model response is preserved. Most previous sensitivity analyses of general aviation activity were predicated on either linear or log-linear sensitivities.

An Example

The GAD model uses the interactive dialogue feature of NUCLEUS to guide the analyst through a series of procedures and options. This technique eliminates the need for preliminary calculations by the user. Simple yes/no responses to NUCLEUS questions establish the conditions of the particular simulation to be run. If the user is uncertain of the parameter values contained in the model, NUCLEUS will display them. If the user desires to change these values, NUCLEUS will accept the new values. Incorrect (or unexpected) response to NUCLEUS questions will simply cause the same question to be repeated.

A sensitivity example, comparing the normal "baseline" forecast to an increased fuel tax (effective January 1, 1977), is discussed below. Not all the options available for input/output are displayed; only enough to illustrate the procedures. In this example, all user entries are underlined.

Following the usual login procedures, the computer will ask,

WOULD YOU LIKE THE FORECAST TO USE THE INITIAL ASSUMPTIONS?

An affirmative answer

/ YES

causes the normal "baseline" simulation to be executed. Upon completion of this simulation, the computer will ask,

WHAT OUTPUT TABLE WOULD YOU LIKE, OR ENTER "LIST" OR "NONE"

The unfamiliar user will not know the available tabular output options. By responding

/ LIST

the following list of output table options will be printed.

```
TABLE        VARIABLES IN TABLE
AIRCRAFT1    ACTIVE AIRCRAFT (AA), BY YEAR
AIRCRAFT2    ACTIVE AIRCRAFT (AA), BY CATEGORY
AIRPORTS     TOWERED AND NON-TOWERED OPERATIONS --- LOPST,IOPST,LOPSNT,
                   IOPSNT,IFROP,VFROP
AIRUTIL      AIRCRAFT UTILIZATION RATES  (AUR)
CONSERVE     CONSERVATION TAX  (CTAX)
ECONOMIC     DPI,GNP,MI
FIXEDCOST    FIXED COST  (FIX)
FUEL         FUEL CONSUMED  (FC) IN MILLIONS OF GALLONS
HOURSFLOWN   HOURS FLOWN  (HF), IN THOUSANDS
OPERATIONS   TOTAL OPERATIONS  (OPS), IN THOUSANDS
PILOTS       SP,PP,CP,P,HP,TP,IP,HR,THP
REVENUE      FEDERAL TAX REVENUE  (FTR)
TOTALS       TOTAL AIRCRAFT, HOURS FLOWN (THOUSANDS)
                   OPERATIONS (THOUSANDS)
VARCOST      VARIABLE COST  (VC)
```

When the list is completed, the previous question will be repeated,

WHAT OUTPUT TABLE WOULD YOU LIKE, OR ENTER "LIST" OR "NONE"

A response of

/ PILOTS

would generate the following table:

GENERAL AVIATION DYNAMIC MODEL PAGE 1

PILOT DATA, 1975 TO 1985

	1975	1976	1977	1978	1979
STUDENT PILOTS	180,800	173,251	173,746	171,663	168,747
PRIVATE PILOTS	305,900	321,414	333,071	344,538	355,130
COMMERCIAL PILOTS	192,500	198,319	204,686	210,350	215,336
PILOT SUBTOTAL	679,200	692,985	711,503	726,551	739,213
HELICOPTER PILOTS	5,647	5,243	4,960	4,666	4,376
TOTAL PILOTS	684,847	698,228	716,464	731,217	743,590
INSTRUMENT RATINGS	199,300	211,543	224,391	236,540	248,005
HELICOPTER RATINGS	22,971	24,178	25,398	26,635	27,881
TOTAL HELIC RATINGS	28,618	29,421	30,358	31,301	32,257

GENERAL AVIATION DYNAMIC MODEL PAGE 2

PILOT DATA, 1980 TO 1985

	1980	1981	1982	1983	1984
STUDENT PILOTS	165,433	159,237	151,942	144,812	138,096
PRIVATE PILOTS	364,632	373,948	382,394	389,685	395,611
COMMERCIAL PILOTS	219,716	222,575	223,892	223,778	222,628
PILOT SUBTOTAL	749,781	755,761	758,228	758,275	756,335
HELICOPTER PILOTS	4,107	3,802	3,488	3,185	2,914
TOTAL PILOTS	753,888	759,563	761,715	761,459	759,250
INSTRUMENT RATINGS	258,836	268,098	275,750	281,878	286,847
HELICOPTER RATINGS	29,126	30,365	31,578	32,749	33,863
TOTAL HELIC RATINGS	33,233	34,167	35,066	35,934	36,777

GENERAL AVIATION DYNAMIC MODEL PAGE 3

PILOT DATA, 1985

	1985
STUDENT PILOTS	131,370
PRIVATE PILOTS	399,183
COMMERCIAL PILOTS	221,680
PILOT SUBTOTAL	752,234
HELICOPTER PILOTS	2,672
TOTAL PILOTS	754,906
INSTRUMENT RATINGS	291,866
HELICOPTER RATINGS	34,909
TOTAL HELIC RATINGS	37,581

Upon completion of the requested output table, the same question will again be repeated,

WHAT OUTPUT TABLE WOULD YOU LIKE, OR ENTER "LIST" OR "NONE".

The user may request as many of the table options as he wants. However, eventually no more tabular data will be desired, prompting the response

/ NONE

The computer will then ask,

WOULD YOU LIKE A "SCATTER " PLOT, A "CONTINUOUS" PLOT, OR "NONE"?

A "scatter" plot is represented by discrete data points, whereas a "continuous" plot performs interpolation between the data points. By answering,

/ SCATTER

the computer will respond,

ENTER THE VARIABLE YOU WOULD LIKE FOR THE Y-AXIS, OR "LIST".

Not being familiar with the plot options, the user responds

/ LIST

which will generate the following list of variables:

IDENTIFIER	DESCRIPTION
AA	ACTIVE AIRCRAFT BY PRIMARY USE
AASUM	TOTAL AIRCRAFT
AUR	AIRCRAFT UTILIZATION RATE (HRS/AC/YR)
CP	COMMERCIAL PILOTS
DPI	DPI (1972 $, 1972=1)
FC	FUEL CONSUMED (GALLONS)
FTR	FEDERAL TAX REVENUE
GNP	GNP (1972 $, 1972=1)
HF	HOURS FLOWN
HFSUM	TOTAL HOURS FLOWN (THOUSANDS)
HP	HELICOPTER PILOTS
HR	HELICOPTER RATINGS
IP	INSTRUMENT RATINGS
MI	MOBILITY INDEX
OPS	OPERATIONS (THOUSANDS)
OPSSUM	TOTAL OPERATIONS (THOUSANDS)
P	PILOT SUBTOTAL
PP	PRIVATE PILOTS
PPA	PILOTS PER AIRCRAFT (EXCLUDES HELICOPTERS)
PPH	PILOTS PER HELICOPTER
SP	STUDENT PILOTS
TC	TOTAL COST
THP	TOTAL HELIC RATINGS
TP	TOTAL PILOTS
VC	VARIABLE COST INDEX ($/HR), (1972 $, 1972=1)

At the conclusion of the list, the computer will state

ENTER VARIABLE

Any variable identifier from the above list can be specified. For example, in order to plot student pilots, the user responds,

/ SP

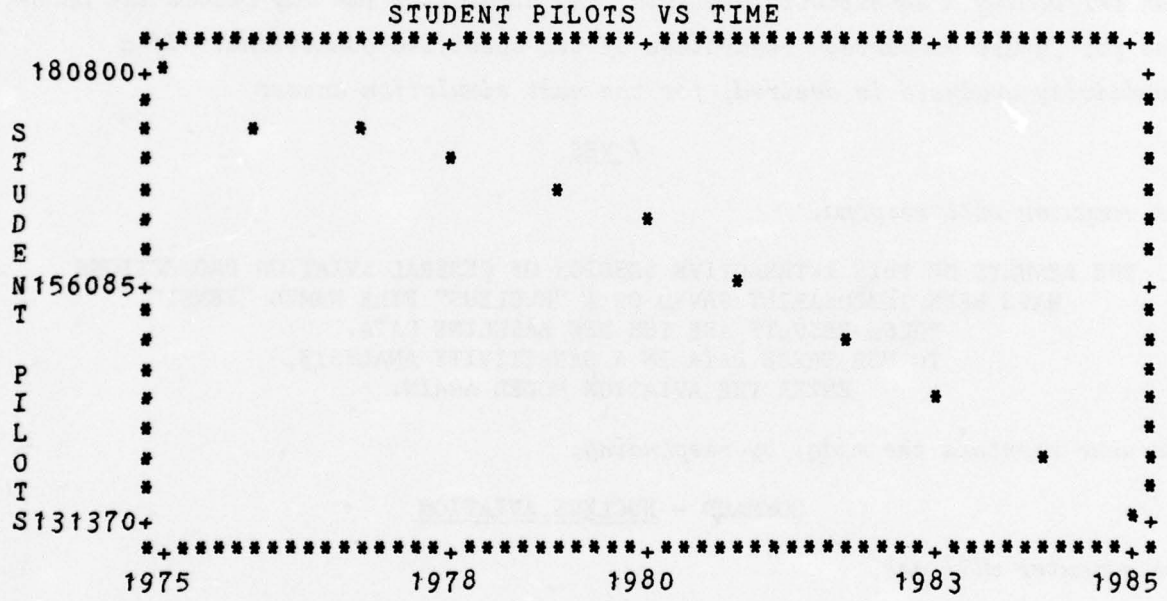
Now the computer will ask,

WOULD YOU LIKE TO PLOT THIS VARIABLE AGAINST ANOTHER ("VAR") OR AGAINST TIME ("TIME")?

By responding,

/ TIME*

the following plot would be displayed,



*Had the user answered

/ VAR

The computer would have responded

ENTER THE VARIABLE YOU WOULD LIKE FOR THE X-AXIS, OR "LIST".

By entering LIST, *the user would obtain a list of all possible variables for the X-axis.*

Upon completion of a plot, the computer will again ask,

WOULD YOU LIKE A "SCATTER" PLOT, A "CONTINUOUS" PLOT, OR "NONE"?

By responding,

/ NONE

the program will exit the output mode and ask,

WOULD YOU LIKE TO COMPARE THE RESULTS OF THIS RUN AND THE BASELINE RUN?

Since this is the first simulation, there is no baseline yet. Therefore, the appropriate response at this point is

/ NO

The computer will then ask,

WOULD YOU LIKE TO SAVE THE RESULTS OF THIS SESSION FOR LATER SENSITIVITY ANALYSIS?

When performing a sensitivity analysis, any simulation run may become the baseline for future comparison regardless of its specified conditions. If a sensitivity analysis is desired, for the next simulation answer

/ YES

The computer will respond,

THE RESULTS OF THIS INTERACTIVE SESSION OF GENERAL AVIATION PROJECTIONS
HAVE BEEN TEMPORARILY SAVED ON A "NUCLEUS" FILE NAMED "SENSY".
THESE RESULTS ARE THE NEW BASELINE DATA.
TO USE THESE DATA IN A SENSITIVITY ANALYSIS,
ENTER THE AVIATION MODEL AGAIN.

The user reenters the model by responding,

COMMAND - NUCLEUS,AVIATION

The computer will ask,

WOULD YOU LIKE THE FORECAST TO USE THE INITIAL ASSUMPTIONS?

Answer

/ NO

since we have already saved the results of this simulation for future comparisons.

The computer will ask,

WOULD YOU LIKE TO EVALUATE THE ULLMAN BILL?

Answer

/ NO

since we do not want this case for the second simulation.
The computer will ask,

WOULD YOU LIKE TO CHANGE OR DISPLAY ANY INITIAL ASSUMPTIONS?
ENTER THE NAME OF THE VARIABLE, OR "LIST", "DISPLAY", OR "NONE".

The user has already decided that the second simulation will involve a fuel tax increase, but he does not know how to implement it into the model. Therefore, answer

/ LIST

which would generate the following list:

AIRCRAFT VARIABLES

IDENTIFIER	DESCRIPTION
ADRN	AIRCRAFT DESTRUCTION RATE, NORMALIZED (AC/YR)
AURN	AIRCRAFT UTILIZATION RATE, NORMALIZED, (HRS/AC/YR)
DAUR	DESIRED AIRCRAFT UTILIZATION RATE (AC/YR)
FIX	FIXED COST, ($/YR)
FTAX	FEDERAL FUEL TAX ($/GAL)
LFEE	LANDING FEE ($/LANDING)
VC	VARIABLE COST INDEX ($/HR), (1972 $, 1972=1)

ECONOMIC VARIABLES

IDENTIFIER	DESCRIPTION
DPI	DISPOSABLE PERSONAL INCOME (1972 $, 1972=1)
GNP	GROSS NATIONAL PRODUCT (1972 $, 1972=1)
MI	MOBILITY

FUEL VARIABLES

IDENTIFIER	DESCRIPTION
SFC	SPECIFIC FUEL CONSUMPTION (GALLONS/HOUR)

PILOT VARIABLES

IDENTIFIER	DESCRIPTION
CPDNYR	COMMERCIAL PILOT DEPARTURE RATE, NORMALIZED
IPDNYR	INSTRUMENT PILOT DEPARTURE RATE, NORMALIZED
PCINYR	PRIVATE PILOT CERTIFICATES ISSUED RATE, NORMALIZED
PPDNYR	PRIVATE PILOT DEPARTURE RATE, NORMALIZED
SPDNYR	STUDENT PILOT DEPARTURE RATE, NORMALIZED
URIPNYR	UPGRADE RATE TO INSTRUMENT FROM PRIVATE, NORMALIZED

OTHER VARIABLES

IDENTIFIER	DESCRIPTION
TIM	ENDING YEAR FOR SIMULATION

Upon completion of the list, the computer will repeat the question,

WOULD YOU LIKE TO CHANGE OR DISPLAY ANY INITIAL ASSUMPTIONS?
ENTER THE NAME OF THE VARIABLE, OR "LIST", "DISPLAY", OR "NONE".

The user can see from the above list that the identifier for federal fuel tax is FTAX; but since he may not know the current tax rates, he answers

/ DISPLAY

The computer will respond,

ENTER NAME OF VARIABLE TO BE DISPLAYED OR "LIST" OR "NONE"

By entering,

/ FTAX

the table on the following page would be generated:

GENERAL AVIATION DYNAMIC MODEL PAGE 1

INITIAL ASSUMPTIONS FOR VARIABLE COST, 1975

SNGL-P NON-AER	SNGL-P AER	MULTI- PISTON	TURBO PROP	TURBO JET	PISTON HELIC	TURBINE HELIC
1.0881	1.0881	1.1052	1.0761	1.1717	1.1593	1.1446

VARIABLE COST INFLATION FACTOR, 1975

1975	1.000
1976	0.999
1977	1.014
1978	1.028
1979	1.040
1980	1.064
1981	1.088
1982	1.110
1983	1.127
1984	1.144

INITIAL ASSUMPTIONS FOR FEDERAL FUEL TAX ($/GAL), 1975

AV GAS	JET FUEL
0.03	0.07

LANDING FEE ($/LANDING), 1975

SNGL-P NON-AER	SNGL-P AER	MULTI- PISTON	TURBO PROP	TURBO JET	PISTON HELIC	TURBINE HELIC
0.00	0.00	0.00	0.00	0.00	0.00	0.00

This table also provides variable cost, variable cost inflation factor, and landing fee information. Upon completion of the display, the computer will again respond:

ENTER NAME OF VARIABLE TO BE DISPLAYED OR "LIST" OR "NONE".

By entering

/ NONE

the computer will repeat the question

WOULD YOU LIKE TO CHANGE OR DISPLAY ANY INITIAL ASSUMPTIONS?
ENTER THE NAME OF THE VARIABLE, OR "LIST", "DISPLAY", OR "NONE".

Since the user now knows the variable to be changed, he answers

/ FTAX

which will cause the computer to respond,

COMPONENTS OF "VC" ARE FUEL TAX AND LANDING FEE.
WOULD YOU LIKE TO CHANGE THE FUEL TAX (FTAX)?

Since fuel tax is the desired variable, answer

/ YES

The computer will ask,

WHAT YEAR WOULD YOU LIKE THE NEW FUEL TAX TO BEGIN?

For a January 1, 1977 date of effectiveness, enter

/ 1977

The computer will ask,

WOULD YOU LIKE THE FUEL TAX TO REMAIN CONSTANT
FOR ALL SUBSEQUENT YEARS?

If the fuel tax is to remain at the January 1, 1977 level for the duration of the simulated time period, enter YES; *otherwise enter*

/ NO

which will cause the computer to ask,

WOULD YOU LIKE THE FUEL TAX TO CHANGE AT A CONSTANT RATE?

If the desired fuel tax is to increase at a constant annual rate over the duration of the simulated time period, enter

/ YES

which will cause the computer to respond,

ENTER RATE OF CHANGE

For a 10 percent annual increase in fuel tax, enter

/ .10

The computer will ask,

WOULD YOU LIKE TO USE THE INITIAL ASSUMPTIONS FOR THE FIRST YEAR
OF THE INCREASED FUEL TAX?

Assuming the user wants a discrete change in fuel tax on January 1, 1977, enter

/ NO

which will cause the computer to respond,

ENTER THE FUEL TAX VALUES FOR FIRST YEAR OF CHANGED FUEL TAX,
IN DOLLARS,
FIRST FOR AV GAS, THEN FOR JET FUEL

In order to have a ¢6 per gallon tax on aviation gas and a 14¢ per gallon tax on jet fuel effective January 1, 1977, enter

/ .06
/ .14

The computer will ask,

WOULD YOU LIKE TO IMPOSE A LANDING FEE?

Since fuel tax is the only component of variable cost to be changed, answer

/ NO

The computer will then return to the original question,

WOULD YOU LIKE TO CHANGE OR DISPLAY ANY INITIAL ASSUMPTIONS?
ENTER THE NAME OF THE VARIABLE, OR "LIST", "DISPLAY", OR "NONE".

Since no other variables are to be changed, the user responds

/ NONE *

At this point the second simulation is executed. Upon completion of the calculations, the computer will ask,

WHAT OUTPUT TABLE WOULD YOU LIKE, OR ENTER "LIST" OR "NONE".

Responding, as for the first simulation,

/ PILOTS

would generate the following table:

*The user may want to check the values he has just entered, in which case,

/ DISPLAY

and

/ FTAX

should be entered as before.

GENERAL AVIATION DYNAMIC MODEL PAGE 5

PILOT DATA, 1975 TO 1985

	1975	1976	1977	1978	1979
STUDENT PILOTS	180,800	173,251	173,746	166,532	161,357
PRIVATE PILOTS	305,900	321,414	333,071	346,075	356,878
COMMERCIAL PILOTS	192,500	198,319	204,686	208,813	212,160
PILOT SUBTOTAL	679,200	692,985	711,503	721,421	730,395
HELICOPTER PILOTS	5,647	5,243	4,960	4,579	4,226
TOTAL PILOTS	684,847	698,228	716,464	726,000	734,621
INSTRUMENT RATINGS	199,300	211,543	224,391	235,004	244,835
HELICOPTER RATINGS	22,971	24,178	25,398	26,635	27,862
TOTAL HELIC RATINGS	28,618	29,421	30,358	31,214	32,088

GENERAL AVIATION DYNAMIC MODEL PAGE 6

PILOT DATA, 1980 TO 1985

	1980	1981	1982	1983	1984
STUDENT PILOTS	156,752	149,558	141,322	133,237	125,679
PRIVATE PILOTS	366,192	375,236	383,446	388,956	391,774
COMMERCIAL PILOTS	214,749	215,642	214,795	213,924	213,230
PILOT SUBTOTAL	737,692	740,436	739,564	736,117	730,682
HELICOPTER PILOTS	3,909	3,576	3,245	2,934	2,660
TOTAL PILOTS	741,601	744,012	742,809	739,052	733,342
INSTRUMENT RATINGS	253,866	261,130	266,564	271,853	277,164
HELICOPTER RATINGS	29,071	30,252	31,388	32,459	33,468
TOTAL HELIC RATINGS	32,980	33,828	34,633	35,393	36,128

GENERAL AVIATION DYNAMIC MODEL PAGE 7

PILOT DATA, 1985

	1985
STUDENT PILOTS	118,156
PRIVATE PILOTS	392,276
COMMERCIAL PILOTS	212,638
PILOT SUBTOTAL	723,070
HELICOPTER PILOTS	2,417
TOTAL PILOTS	725,487
INSTRUMENT RATINGS	282,390
HELICOPTER RATINGS	34,420
TOTAL HELIC RATINGS	36,837

Upon completion of the table, the computer will again ask,

WHAT OUTPUT TABLE WOULD YOU LIKE, OR ENTER "LIST" OR "NONE".

By responding, as before,

/ NONE .

the computer will ask,

WOULD YOU LIKE A "SCATTER" PLOT, A "CONTINUOUS" PLOT, OR "NONE"?

Responding,

/ NONE

will cause the computer to ask,

WOULD YOU LIKE TO COMPARE THE RESULTS OF THIS RUN AND THE BASELINE RUN?

Since both simulations for the sensitivity analysis have been run, answer

/ YES

The computer will ask,

WHAT OUTPUT TABLE WOULD YOU LIKE, OR ENTER "LIST" OR "NONE".

The list of output tables for sensitivity analyses is a subset of the list for absolute forecasts. Therefore, the unfamiliar user should answer,

/ LIST

which would generate the following list of output tables:

TABLE	VARIABLES IN TABLE
AIRCRAFT1	ACTIVE AIRCRAFT (AA), BY YEAR
AIRCRAFT2	ACTIVE AIRCRAFT (AA), BY CATEGORY
AIRPORTS	TOWERED AND NON-TOWERED OPERATIONS --- LOPST,IOPST,LOPSNT, IOPSNT,IFROP,VFROP
FUEL	FUEL CONSUMED (FC)
HOUR WN	HOURS FLOWN (HF), IN THOUSANDS
OPER ONS	TOTAL OPERATIONS (OPS), IN THOUSANDS
PILOTS	SP,PP,CP,P,HP,TP,IP,HR,THP
REVENUE	FEDERAL TAX REVENUE (FTR)
TOTALS	TOTAL AIRCRAFT, HOURS FLOWN (THOUSANDS) OPERATIONS (THOUSANDS)

Upon completion of the table list, the computer will again ask,

WHAT OUTPUT TABLE WOULD YOU LIKE, OR ENTER "LIST" OR "NONE"

By responding,

/ PILOTS

The following table of percent deviations would be generated:

GENERAL AVIATION DYNAMIC MODEL PAGE 13

PILOT DATA, % DEVIATION FROM BASELINE, 1975 TO 1985

	1975	1976	1977	1978	1979
STUDENT PILOTS	0.00	0.00	0.00	-2.99	-4.38
PRIVATE PILOTS	0.00	0.00	0.00	0.45	0.49
COMMERCIAL PILOTS	0.00	0.00	0.00	-0.73	-1.47
PILOT SUBTOTAL	0.00	0.00	0.00	-0.71	-1.19
HELICOPTER PILOTS	0.00	0.00	0.00	-1.87	-3.45
TOTAL PILOTS	0.00	0.00	0.00	-0.71	-1.21
INSTRUMENT RATINGS	0.00	0.00	0.00	-0.65	-1.28
HELICOPTER RATINGS	0.00	0.00	0.00	0.00	-0.07
TOTAL HELIC RATINGS	0.00	0.00	0.00	-0.28	-0.52

GENERAL AVIATION DYNAMIC MODEL PAGE 14

PILOT DATA, % DEVIATION FROM BASELINE, 1980 TO 1985

	1980	1981	1982	1983	1984
STUDENT PILOTS	-5.25	-6.08	-6.99	-7.99	-8.99
PRIVATE PILOTS	0.43	0.34	0.28	-0.19	-0.97
COMMERCIAL PILOTS	-2.26	-3.12	-4.06	-4.40	-4.22
PILOT SUBTOTAL	-1.61	-2.03	-2.46	-2.92	-3.39
HELICOPTER PILOTS	-4.82	-5.96	-6.95	-7.86	-8.73
TOTAL PILOTS	-1.63	-2.05	-2.48	-2.94	-3.41
INSTRUMENT RATINGS	-1.92	-2.60	-3.33	-3.56	-3.38
HELICOPTER RATINGS	-0.19	-0.37	-0.60	-0.89	-1.17
TOTAL HELIC RATINGS	-0.76	-0.99	-1.23	-1.50	-1.76

GENERAL AVIATION DYNAMIC MODEL PAGE 15

PILOT DATA, % DEVIATION FROM BASELINE, 1985

	1985
STUDENT PILOTS	-10.06
PRIVATE PILOTS	-1.73
COMMERCIAL PILOTS	-4.08
PILOT SUBTOTAL	-3.88
HELICOPTER PILOTS	-9.56
TOTAL PILOTS	-3.90
INSTRUMENT RATINGS	-3.25
HELICOPTER RATINGS	-1.40
TOTAL HELIC RATINGS	-1.98

Note that deviations from the baseline do not occur until January 1, 1978. This is because the data reported on January 1, 1978 represents conditions during the previous calendar year.

Upon completion of the table, the computer will again ask,

WHAT OUTPUT TABLE WOULD YOU LIKE, OR ENTER "LIST" OR "NONE".

Responding,

/ NONE

will cause the computer to ask,

WOULD YOU LIKE A "SCATTER" PLOT, A "CONTINUOUS" PLOT, OR "NONE"?

Responding,

/ SCATTER

will cause the computer to state,

ENTER THE VARIABLE YOU WOULD LIKE FOR THE Y-AXIS, OR "LIST".

For example, in order to display the percent deviation in fuel consumed between the two simulations, enter

/ FC

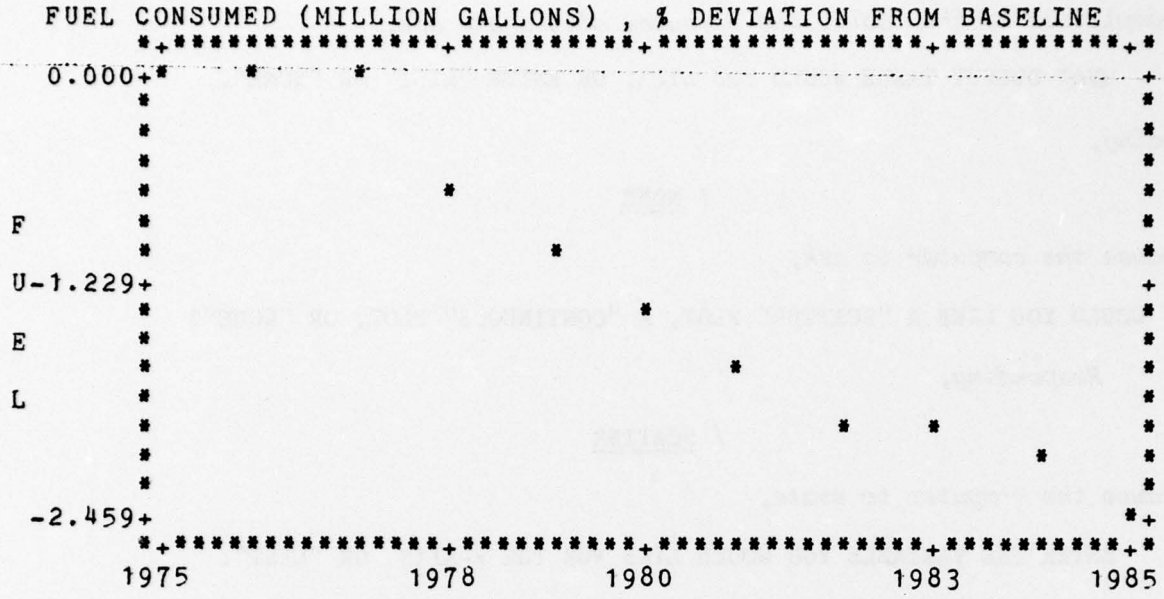
The computer will respond,

PLEASE ENTER "AV" OR "JET" FOR SELECTION OF FUEL FOR PLOT.

By entering,

/ AV

the following plot would be generated:



Upon completion of the plot, the computer will again ask,

WOULD YOU LIKE A "SCATTER" PLOT, A "CONTINUOUS" PLOT, OR "NONE"?

Responding,

/ NONE

will cause the computer to ask,

WOULD YOU LIKE TO SAVE THE RESULTS OF THIS SESSION FOR LATER SENSITIVITY ANALYSIS?

Since the sensitivity analysis has already been performed, answer

/ NO

The user may investigate the impact of changing another variable by re-entering the model. A sensitivity analysis will compare these new results to the original baseline. However, had the user responded

/ YES

to this question, the next sensitivity analysis would use the results of this simulation for the baseline, rather than the results of the first simulation.

The computer will respond,

```
YOU HAVE FINISHED THIS SIMULATION PERIOD.
TO SIMULATE NEW LEVELS OF GENERAL AVIATION ACTIVITY,
ENTER THE AVIATION MODEL AGAIN.
COMMAND- LOGOUT
CP          XX.XXX      SEC.
IO          XX.XXX      SEC.
CM          XX.XXX      SEC.
SS          XX.XXX      SEC.
CH           XXXXX      CHARS.
CONNECT TIME     X HRS.    XX MIN.
 11/09/76  LOGGED OUT AT 09.45.29.
```

Summary

This example illustrates the ease in which the General Aviation Dynamics model can be used to obtain either absolute forecasts or perform sensitivity analyses. It should be emphasized again that this has only been a representative example. Neither all the output nor all the options available have been displayed.

Sensitivity analyses consist of making changes in the model, usually in the value of a particular parameter, and comparing the evolution of general aviation simulated with the change to the evolution simulated without the change. This procedure is helpful in identifying those parameters or aspects of the model that could make significant differences in the projections. To the extent that the model is a valid representation of reality, these same parameters can be used as policy measures which influence the future of general aviation.

Normally, the following sequences of events occur,

(1) run the first simulation which becomes the base case for future sensitivity analyses

(2) run the second simulation which incorporates a model change from the first simulation

(3) compare the differences between the two simulations.

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